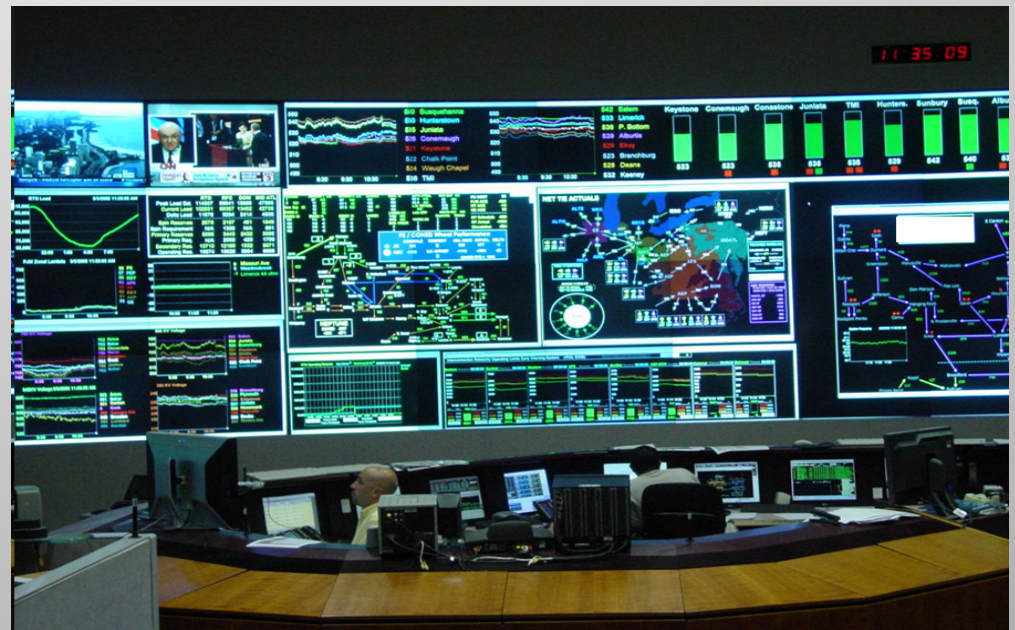


Value of Measurement and Power Provider Communications in High Performance Computing

Supercomputing 2013

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HPC - Value of Metrics and Communications

- HPC - What is being measured?
- Operational Questions
- Data from Disparate sources
- Operational Challenge
- Power Provider Perspective
- Communications between HPC Center and Power Provider

Measurement and Communications

Measure to Manage

MEASUREMENTS

Power

- Quality
- Load
- UPS Batteries
 - Float Voltage
 - Temperature

Mechanical

- Chillers
 - Set points
 - Efficiencies
- CRAC
 - Humidity
 - Temperature
- Liquid Cooling
 - Water quality
 - Flow
 - Pressure

IT

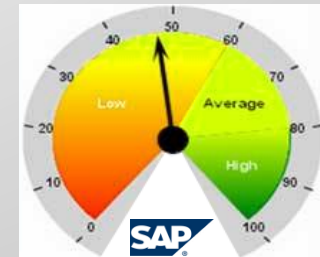
- Network
- Device Performance
- Server
- Job scheduling

OPERATIONAL QUESTIONS

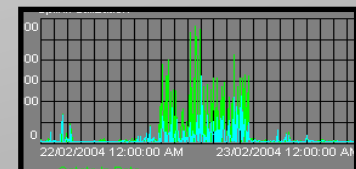
- How are these measurements monitored?
- What is impact of job scheduling on power demand variations?
- What is impact of scheduled maintenance?
- What provisions are made to communicate variations to power provider?
- Impact on performance

OUTCOME

- Power forecasts based on real data
- Improved efficiency



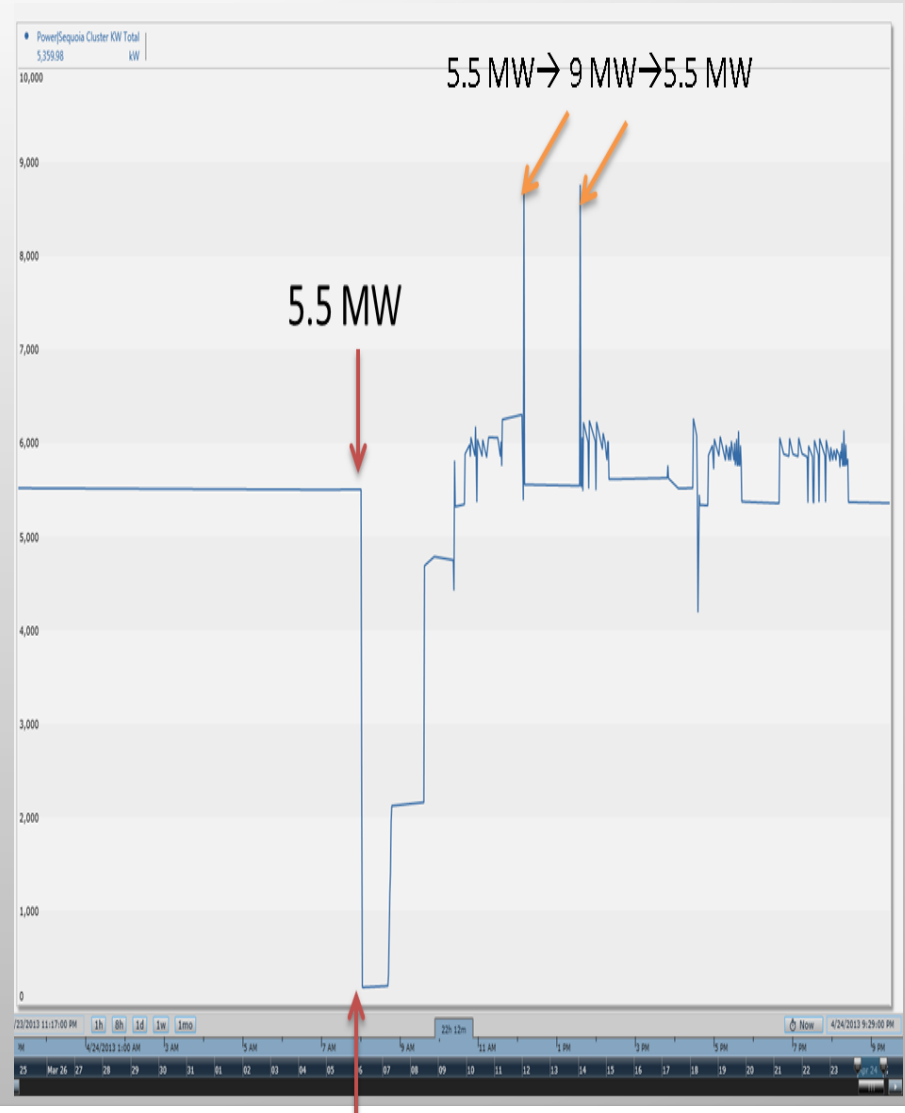
- Predictability
- Reliability
- Provider relationship



Operational Challenge

From Anna Maria's Intro:

- Recent installed HPC systems have raised concerns with some utilities
- Requires modeling power consumption and quality of large HPC computational block loads
- Requires the need to address operational cost increases with larger load
- Requires the ability to know what to monitor
 - Continually log events of HPC workload to include scheduled maintenance, unscheduled power interruptions, power glitches, etc. to gain broader knowledge



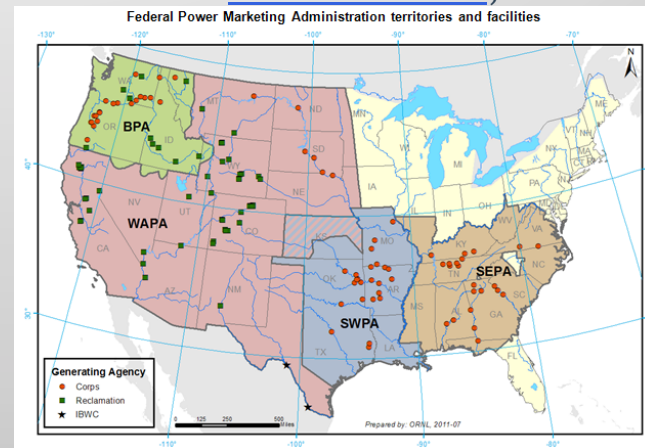
Communications With Power Provider

- HPC facilities are using increasing amounts of power
- Top 25 HPC sites use between <1 and 20+ MW
- Scheduled maintenance can result in 5 MW load swings to the grid in a short period of time
- Other sources and patterns of power variation need to be better understood
- HPC centers are just beginning to engage in demand dialog with their power providers
- For larger HPC Centers, there is value in regular communications with providers



Power Provider Perspective - WAPA

- Western Area Power Administration (WAPA) markets and transmits hydroelectric power from 57 powerplants operated by the [Bureau of Reclamation](#), the [U.S. Army Corps of Engineers](#).
- WAPA's Sierra Nevada Region manages transmission facilities in California:
 - 50% of SN's load is located in the Sacramento Municipal Utility District's balancing authority area.
 - 50% is located in the California Independent System Operator (CAL ISO) balancing authority area.
- WAPA must operate the balancing authorities in accordance with [NERC standards](#), including:
 - Operating Reserves
 - Automatic Generation Control
 - Frequency Response
 - Power Balancing Control Performance
 - Emergency Operations
 - Capacity Emergencies
 - Verification of Power Capability
 - Voltage and Reactive Capacity
- Failure to operate in accordance with guidelines can cause grid instability, fines.
- WAPA needs to understand the dynamic load characteristics of its large power users
- WAPA adjusts dam gate flow and spill based on power forecasts

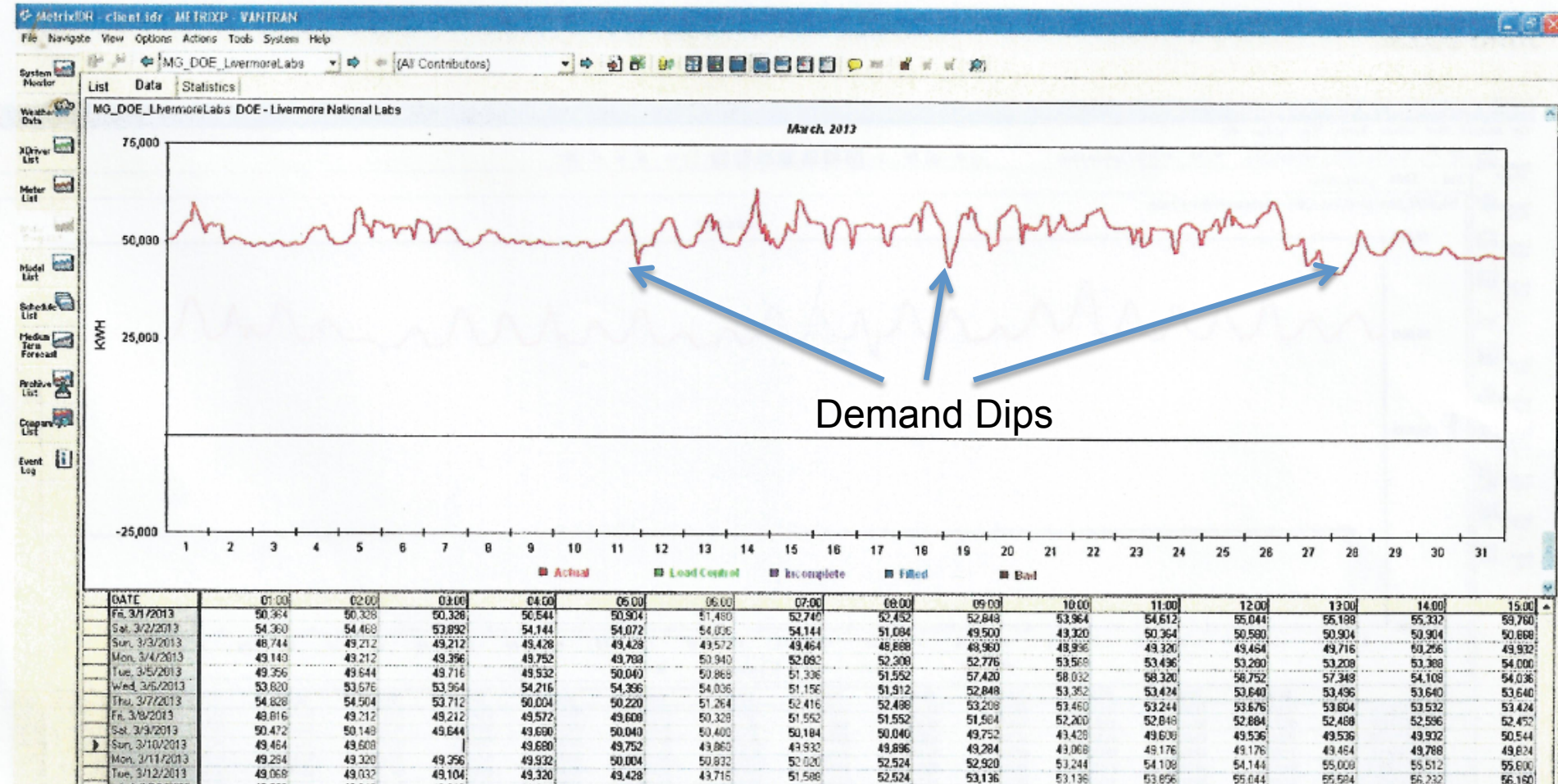


WAPA-LLNL Relationship

- WAPA supplies power to LLNL, LBL and SLAC
- Power forecasting at LLNL and elsewhere can be challenging - 5 MW swings
- LLNL HPC Maintenance occurs every Wednesday. Neither depth nor duration of power dip is sufficiently predictable. Not enough cycles.
- LLNL is capturing additional data on load profile during maintenance and other times
- WAPA requirements
 - Want demand variation to be <5%
 - Want forecast 2 days in advance; 5 days in advance for holidays.
- WAPA has 90 minute window in which to do power forecast
- Data at WAPA's planning desk is 6 hours old.
- WAPA needs data by 10AM Monday for Wednesday (LLNL maint day) forecast.
- Opportunity to explore secure link between LLNL and WAPA to eliminate time lag

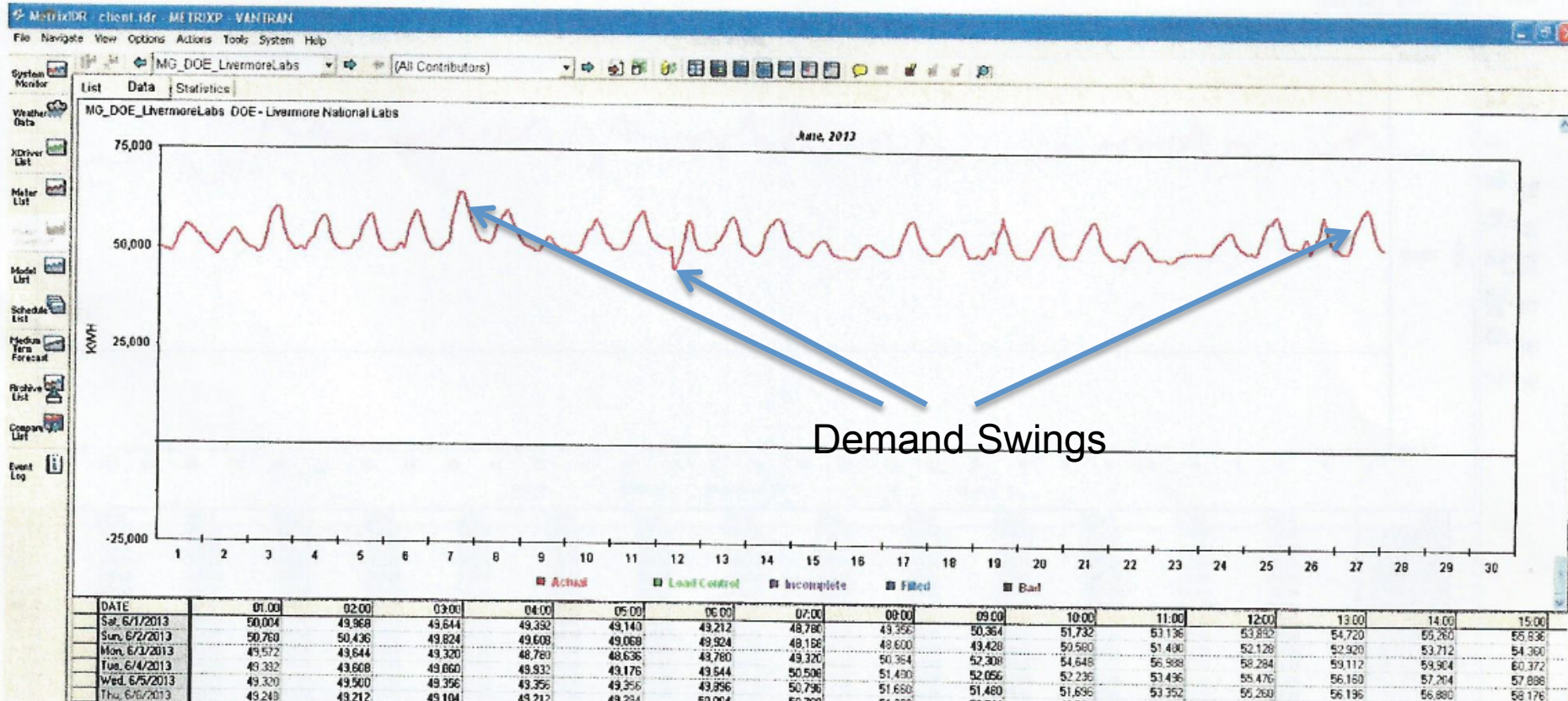
Power Provider - WAPA View of LLNL Load

March 2013:



Power Provider - WAPA View of LLNL Load

June 2013:



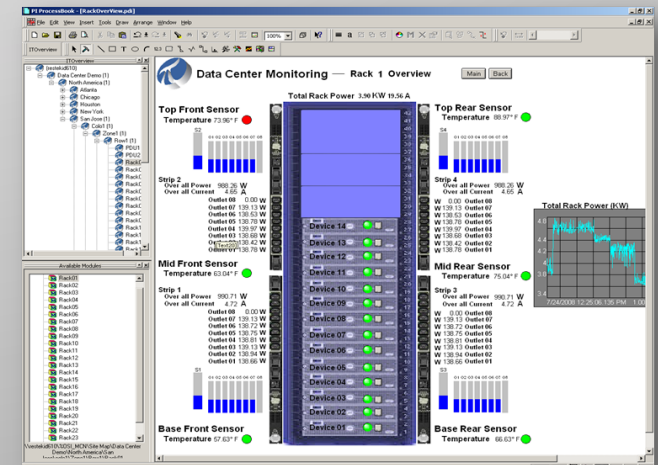
Value of Communications

- With near real time connection, WAPA will have better information with which to prepare power forecast
- Known power variations (heavy loads, scheduled maintenance, vacation days) can be built into WAPA forecasts.
- Improved forecasts and communications can help avoid unexpected peaking or sell-off effects for WAPA.



Summary

- Have a plan for sensors and measurements - fill in gaps
- Track power usage and patterns for different operational situations
- Build model for power forecasting
- Adjust model with cycles and experience
- Improve Communications with Power Provider



Questions?

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